# “Scholarly tricks” - cultural arbitraries in Oxbridge entrance?

Rachel Sharkey shares some of the findings of her Doctoral thesis on how students in private schools might have an advantage when they apply to Oxbridge and other elite universities, as presented at BSRLM's June Conference (Sharkey, 2017b).

## Introduction

There is a widely held belief that students from private schools have an advantage over students in state schools, in part, because students from private schools are overrepresented at elite universities. My thesis (Sharkey, 2017a) considered how teachers in a private school think they give their students an advantage when they apply to elite universities. Here I briefly report on part of my research project, a case study of a preparation programme at a private school, aimed at students who wish to apply to elite universities, and reflect on my own practice of preparing students for application and admission to elite universities. The preparation programme consisted of a weekly lesson, given by subject with one or two teachers for each subject. Students were free to choose to opt into the lessons which were given at a lunchtime or after school.

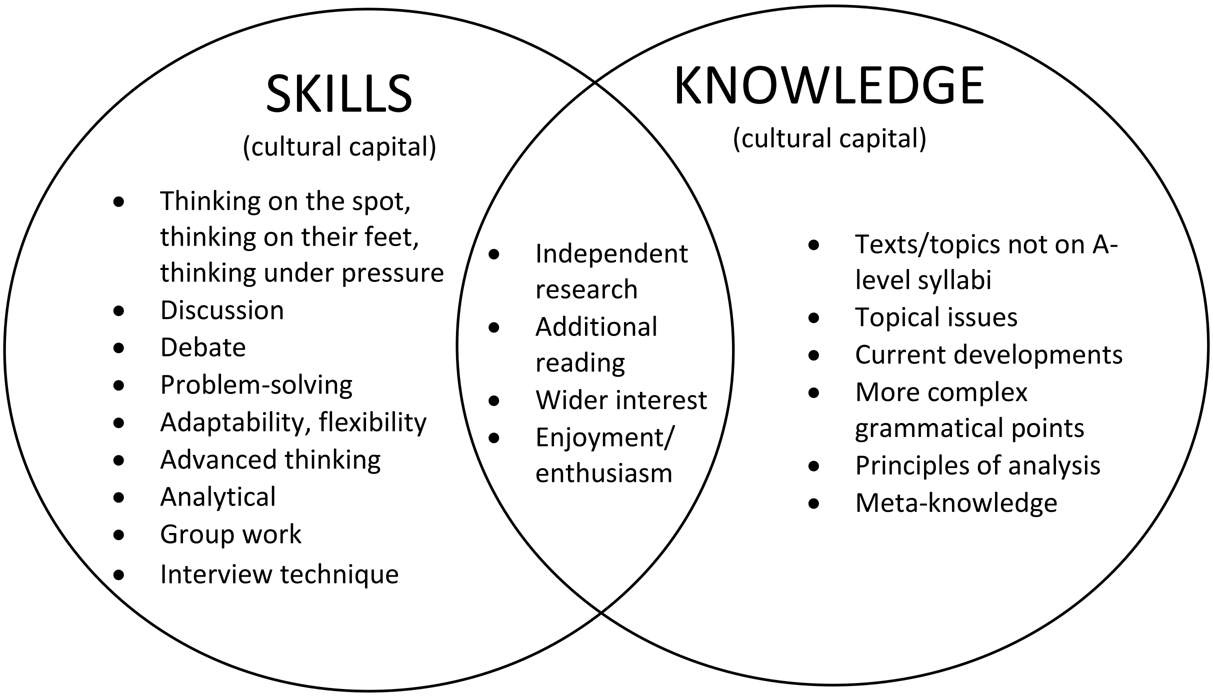


*Figure 1*

I began by exploring the skills and knowledge that teachers (across all subjects) aimed to develop in their students through the programme; this is summarised in Figure 1 [Insert figure 1]. The skills which are particularly applicable to mathematics are problem-solving, adaptability/flexibility and thinking under pressure. The programme enabled a transmission of cultural capital from teacher to student (and between students). By having autonomy over what they do in the programme the teachers were able to choose what they teach and how to teach it. The teachers used their own cultural capital and social capital to inform the content of the programme lessons and the teaching and learning approaches that best facilitated a transmission of capital.  This autonomy, combined with teachers' capital, allowed movement from what is the norm at A-level to the skills and knowledge taught through the programme to make the students stand out in university applications.

Figure 2 shows how the skills and knowledge in Figure 1 differed from those taught in normal A-level lessons.

| **The norm at A-level** | **Distinction in the programme** |
|---|---|
| Thinking about texts but given time to do so | Thinking on the spot/thinking on your feet/thinking under pressure<br>Advanced thinking |
| Discussion and debate of topics on A-level curriculum | Discussion and debate of topics beyond/outside the A-level curriculum |
| Reading what is required for the exam | Additional/wider reading |
| Problem solving | Unstructured problem solving<br>Adapting known methods<br>Using a flexible approach |
| Teacher-led sessions | Student-led discussions and debates |
| Consider distinct parts of a subject | Awareness of the interconnectivity, chronology or holistic nature of a subject |
| | Interview technique, including having ammunition and anecdotes |
| | Develop a love/enjoyment of the subject |

*Figure 2*

What makes these different to normal A-level mathematics lessons is the fact that rather than just developing, for example, problem solving skills, that in my experience forms part of the A-level mathematics syllabus, it is unstructured problem solving, adapting known methods and using a flexible approach that are the skills developed through the programme lessons, i.e. students knowing how to go about solving a problem and what methods to use without being told in the question. By moving students from having the skills on the left hand side of the table to those on the right hand side, not only could it be argued that the students are learning to become better mathematicians, it could also be argued that they have an advantage in the admissions tests (Mathematic Admissions Test (MAT) and STEP) for some elite universities (Oxford, Cambridge, Imperial, Warwick). Whilst, I would expect these to be skills that a mathematician would have and that, as mathematics teachers, we should be fostering in our students, I will give some examples which demonstrate how these skills might provide an advantage. The skills which might give students an advantage I have called “scholarly tricks”; scholarly as they hold academic merit for mathematicians, and trick as they become a cultural arbitrary in the admissions process.

## Completing the square

I suggest that the technique of completing the square is a scholarly trick. The following is an example of a question taken from an A-level paper which instructs students to complete the square.

> Express $3x^2 - 12x + 5$ in the form $a(x - b)^2 - c$. Hence state the minimum value of $y$ on the curve $y = 3x^2 - 12x + 5$.
>
> (OCR MEI, 2013)

Students will have been taught the method and will know to use it as they are told to explicitly. However, in the following question, taken from an Oxford MAT paper (2008), students are not told to complete the square to help them answer this question.

> Which of the following sketches is a graph of $y = \dfrac{1}{4x - x^2 - 5}$ ?
>
> (Oxford University, 2008)

There are four answers to choose from; each graph is a curve with a stationary point, however, the stationary point is in a different quadrant for each of the graphs.

I argue that if the students use the method of completing the square on the quadratic then they would be answering the question more efficiently than if they try, for example, differentiating to find the turning point and its nature.

Reflecting on my own practice, I have realised that, in the programme lessons, I train my students to complete the square if they see a quadratic on a MAT or STEP paper. It would not necessarily be obvious to an A-level student that completing the square is an appropriate method to use, unless they had been told specifically by someone at some point or, you might argue, they were a natural mathematician.

The next example, taken from an Oxford MAT paper (2014), I think shows how beautiful, as well as useful, the technique of completing the square can be.

> The graph of the function $y = 2^{x^2 - 4x + 3}$ can be obtained from the graph $y = 2^{x^2}$ by
>
> (a) a stretch parallel to the y-axis followed by a translation parallel to the y-axis,
> (b) a translation parallel to the x-axis followed by a stretch parallel to the y-axis,
> (c) a translation parallel to the x-axis followed by a stretch parallel to the x-axis,
> (d) a translation parallel to the x-axis followed by reflection in the y-axis,
> (e) reflection in the y-axis followed by translation parallel to the y-axis.
>
> (Oxford University, 2014)

By completing the square on the quadratic, this question can then be answered by applying the rules of transformations learnt at A-level.

## Longer questions on admissions tests

I will now look at an example of a longer question taken from an Oxford MAT paper (2009) and the skills which will help the students in the admissions test:

> For a positive whole number, *n*, the function $f_n(x)$ is defined by
>
> $$f_n(x) = (x^{2n-1} - 1)^2 \ .$$
>
> (i) On the axes provided opposite, sketch the graph of $y = f_2(x)$ labelling where the graph meets the axes.
> (ii) On the same axes sketch the graph of $y = f_n(x)$ where *n* is a large positive integer.

(iii) Determine $\int_0^1 f_n(x)dx$ .

(iv) The *positive* constants *A* and *B* are such that

$$\int_0^1 f_n(x)dx \le 1 - \frac{A}{n+B} \text{ for all } n \ge 1 .$$

Show that $(3n-1)(n+B) \ge A(4n-1)n$, and explain why $A \le \frac{3}{4}$ .

(v) When $A = \frac{3}{4}$ , what is the smallest possible value of *B* ?

(Oxford University, 2009)

This question can cause difficulty for an applicant for several reasons. Firstly, there is an abstractness to this question for an A-level student as there is no apparent context. In addition, it appears complex due to the mix of, what are normally, distinct areas of mathematics for an A-level student: functions, integration, inequalities. In the programme lessons, I teach the students not to be put off by this. Nor should students be deterred by the need for lengthy algebra to reach the solution, but should learn to persevere, another skill I teach through the programme lessons.

Another “trick” is knowing to use previous parts of the question without being told. In A-level, the use of previous parts of a question is signalled by words such as “Hence” or “Therefore”. There are no such words in this MAT question. Yet, part (iv) uses part (iii), and, perhaps less obviously, part (v) uses the fact than *n*≥1 from part (iv).

## Conclusion

In conclusion, I think that the programme facilitates a transfer of capital from teacher to student, or to put it another way, for “scholarly tricks” and skills to be taught that normal A-level lessons do not enable due to curriculum and time constraints. It could be argued that these “scholarly tricks” and skills give a student an advantage in the admissions process; for example, if students are taught, to complete the square when they are presented with a quadratic, they might answer a question more efficiently enabling the student to move on to other questions more quickly. As such, the method of completing the square has exchange value in the admissions process; it becomes arbitrary in practice if it used to discriminate in the selection process for Oxbridge. However, we can argue that the method of completing the square is functional in practice if it is used to help solve harder mathematical problems and as such has use value. It could be argued that teaching students to apply these techniques to a problems, when not explicitly told to apply them, will encourage the students to try similar approaches to other harder problems and thus make them into better mathematicians. Whilst it looks like they are being good mathematicians, the students have in fact been given a technique to apply to questions of this sort in the admissions tests and so if presented with problems in a different context they might not necessarily think to apply these techniques. Completing the square and other techniques and skills might be desirable in applicants, hence the use of questions designed to test these. However, if this is the case, then perhaps this should be made clear to all applicants, so that the tests discriminate fairly between applicants and do not favour those who have access to particular capital.

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